

### **Power Tower R&D**

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## **Outline of Presentation**

From an R&D perspective:

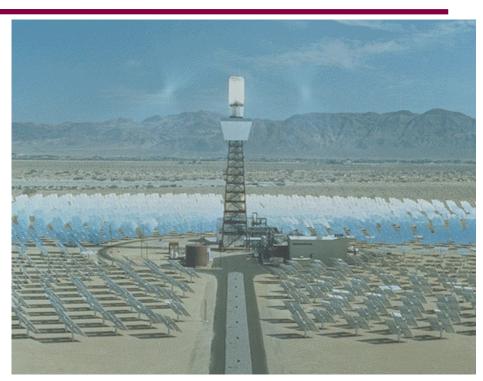
...Where We've Been

Where We're at Now

Where We're Going...

### **Solar One**

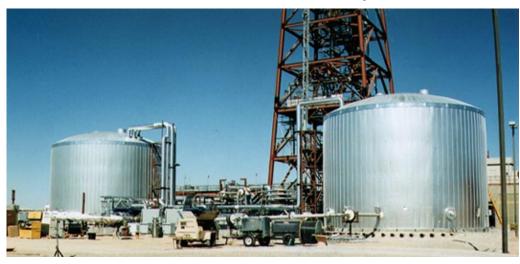
- 10MWe power tower demonstration plant
- Water/steam as heat transfer fluid
- Successes
  - Power tower proof-of-concept
  - 3-year power production phase
  - Utility-scale electricity
     generation—over 42,000 MWh

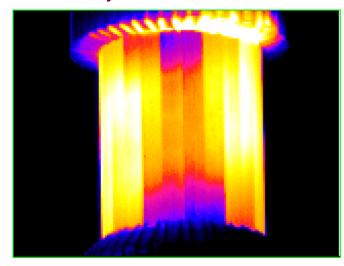


- Limitations due to water/steam
  - Inefficient storage
  - Receiver must be high-pressure gas heat exchanger
     High pressure→Thick-walled tubes→Low flux capability
  - Electricity generation directly coupled to solar energy collection (Clouds tripped turbine)

# Molten Salt Advantages

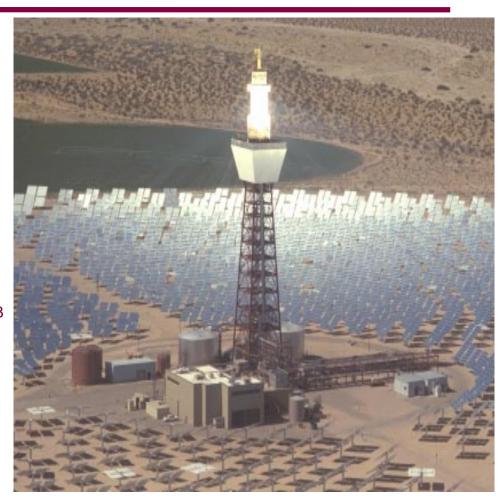
- Efficient storage of thermal energy
  - High capacity factor
  - Dispatch electricity for utility peaks, maximizes value of electricity without use of fossil fuels
- Low-pressure heat exchanger Low pressure → Thin-walled tubes → high flux capability
- Extensive R&D by Industry and Sandia
  - Salt receivers
  - Pump & Valve Test
  - Material corrosion experiments Salt chemistry
- Molten-Salt Electric Experiment
- Salt Storage Experiment





### **Solar Two**

- 10MWe demonstration of molten-salt power tower technology
- Nitrate salt as heat transfer and energy storage medium 60 wt% NaNO<sub>3/</sub>40 wt% KNO<sub>3</sub> 3-hour storage
- Retrofit of Solar One



# **Solar Two Significance**

- → Met objective of technology validation
- Receiver: Validated design, performance and operation of a large-scale molten-salt receiver system
- Storage: Demonstrated use of bulk quantities of molten-salt as heat transfer and thermal storage medium
  - Highly efficient: >97%
  - Inexpensive: ~\$10/kWh<sub>t</sub>
  - Simple: Externally insulated, field-erected tanks
- Demonstrated Dispatchability
   Operated after dark, even around the clock
- Demonstrated performance of a new receiver panel New alloy, new panel design
- → Lessons learned being applied to next plants
- → Met all major goals, including:

"Stimulate interest in forming a commercial consortium"

#### Where We're at Now

#### Bringing molten-salt power towers to commercialization

- Integrating lessons learned into power tower design Examples (*More on this in next presentation*):
  - Reduce number of salt valves
  - Don't use ball valves for salt service
- Incorporating design enhancements Examples (*More on this in next presentation*):
  - Long-shafted hot and cold salt pumps
  - New receiver design
- Testing advanced components
  - Needs identified by industry requests/roadmap
  - Further reduce cost, improve reliability
  - These include:
    - New valve and instrument designs
    - Head-reducing downcomer
    - Heliostat components

#### Where We're At Now

#### Development of a Long-Shafted Salt Pump

- With Nagle Pumps, Inc. and Nexant
- Salt-cooled bearings
- Mounts directly above hot and cold salt storage tanks
- Eliminates 2 sumps, 6 large salt valves, heat trace, insulation
- Reduces plant O&M, increases reliability



#### Where We're At Now

## Reducing Risk and Improving Technology

- Utilize unique molten-salt test facilities
  - Further tests on long-shafted pump
  - Advanced valve and instrument designs
- Heliostat component testing
  - Environmental chambers
  - Pull tests



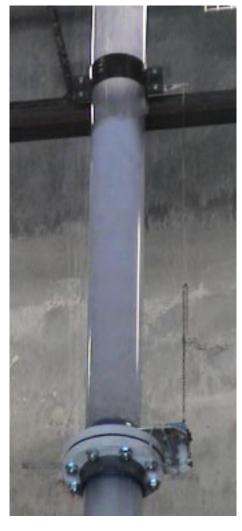


## Where We're At Now

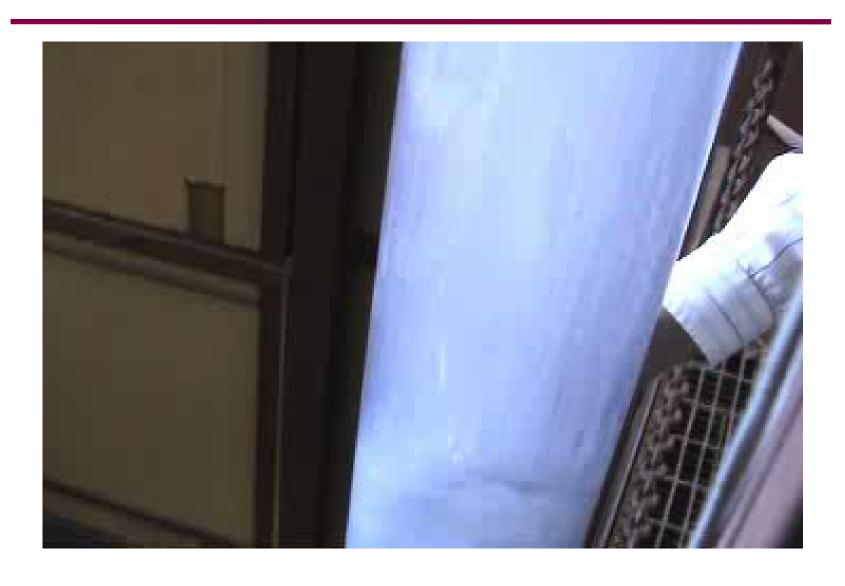
## Development of a Head-Reducing Downcomer







# **Downcomer w/ 13-Hole Orifice Plates**



# Where We're Going: A Roadmap

- Develop commercial molten-salt power tower design incorporating design enhancements
- Progression of plants based on price support and scale-up
  - → Solar Tres
    - →50 MWe plants in US and worldwide
      - → 100MWe commercial plants worldwide
- Develop next round of improvements and cost reductions

# **Summary**

- We have fielded two successful 10MWe demonstration plants
- We have incorporated lessons learned
   Solar One→Solar Two→Solar Tres→Commercial design basis
- We are ready for a 3x scale-up (Solar Tres)
- Industry/labs working on first commercial plant
  - CRADA's
  - Testing at NSTTF
  - Labs participate in Solar Tres design, test, evaluation, operation

Molten-salt power towers emerge as viable sources of grid-scale electricity